High Quality RGB/NTSC Video:

Improving Video Quality in the Access Grid

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Berkeley Video Projects

- RTPtv
  - Transmits “broadcast quality” television across an IP-based network (e.g., Internet2) using RTP
  - Synchronized audio and video
    - Full frame/full quality video
    - High quality, RED-encoded audio
- RGB capture
  - Transmits high-quality, low-loss RGB images
  - Eliminates the use of “scan conversion”

RTPtv

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RTPtv Technical Overview

- MJPEG ("motion JPEG") codec
  - NTSC or PAL, D1 or CIF size
- Video encoded/decoded using MJPEG board
- Constant bitrate mode: variable quality
  - D1 interlaced: 5-30Mbps (10-15Mbps typical)
  - CIF progressive: 1.5-10Mbps (5Mbps typical)
- Variable bitrate mode: fixed image quality
  - Bitrate generally ~10Mbps, but can be 3-13Mbps
- Reduced frame rate can be used
- Another method: send only every other field

RTPtv using Television

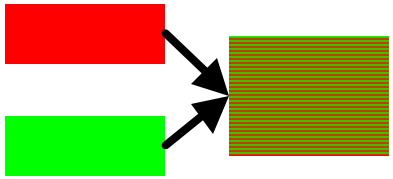
RTPtv using PC Monitor

D1 Interlaced Video

- Television video frame consists of two fields
- Rows of the two fields are combined/ interleaved to form a single video frame
- The first field is drawn, followed by the second

Odd Field

Even Field



Combined Frame Image

CIF Progressive Video

- Transmit image that is 25% original size
  - Only one field is transmitted
  - Field is reduced horizontally 50%
- "Pixel Doubling" used to obtain a full-size image

Field

Field Shrunk Horizontally

Restored Image on Receiver

Transmitting JPEG over IP

- To transmit JPEG over IP, image divided into pieces that can be sent over the network
  - Problem: vic drops entire frame if a single network packet is lost
  - Solution: use “restart markers”
- RTPtv substitutes lost data with corresponding video image from previous field
  - Open Mash vic to support partial frames (soon)
  - Other vics can’t handle restart markers
  - RTP processing & JPEG decoder are non-compliant

RTPtv Hardware

- Video is encoded/decoded using MJPEG board
  - LML33 produced by Linux Media Labs ($410)
  - up to four LML33 boards in a single PC
- LML33 Linux driver is available via GPL
  - RTPtv video currently operates only on a Linux PC
  - Driver enhanced to provide precise timestamps
- Software decoding of video is possible, but lower quality
- Open Mash vic
  - Can receive video up to 30fps for CIF
  - For D1, takes one field and line-doubles image

RTPtv Software

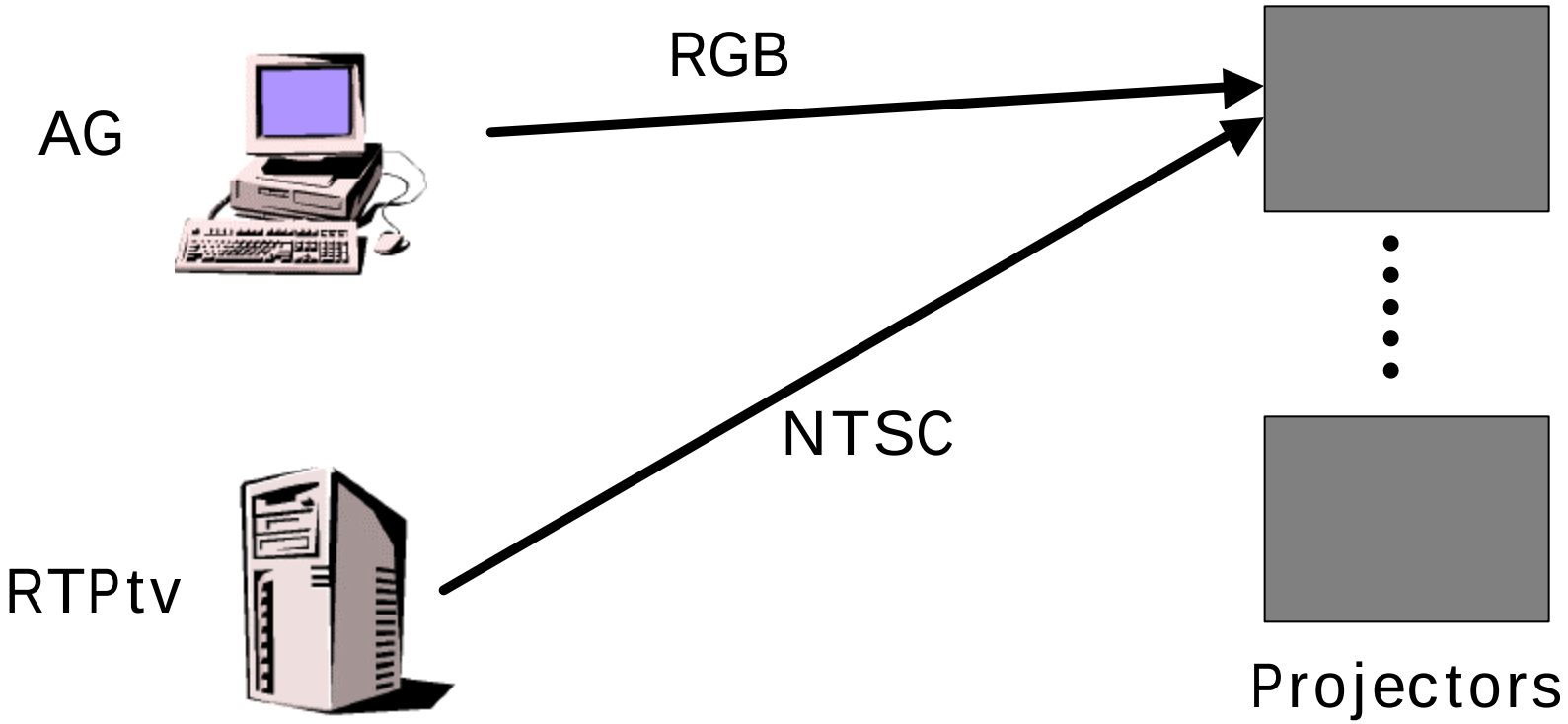
- RTPtv Software available in various forms
  - Separate command-line applications/daemons
  - Tcl/Tk GUI interface is available
  - RPC interface (Tcl/DP syntax)
- Open Mash support for RTPtv/LML33
  - vic can receive and software decode the images
  - Support for restart markers is being refined
  - vic doesn't currently utilize the LML33 hardware
    - Bob Riddle (Internet2) is working on this

RTPtv/AG Integration

- Works today in Open Mash with Software Decoding
  - Requires significant CPU resources
  - P3/800 renders D1 @ 24 fps, CIF @ 30 fps
- LML33 Works in AG Capture Machine (Linux)
  - Can use for raw or compressed capture
  - Machine can also be used for receive/playback
- Hardware needed to scale to more streams
- Issues with incorporating hardware with AG

RTPtv/AG Integration

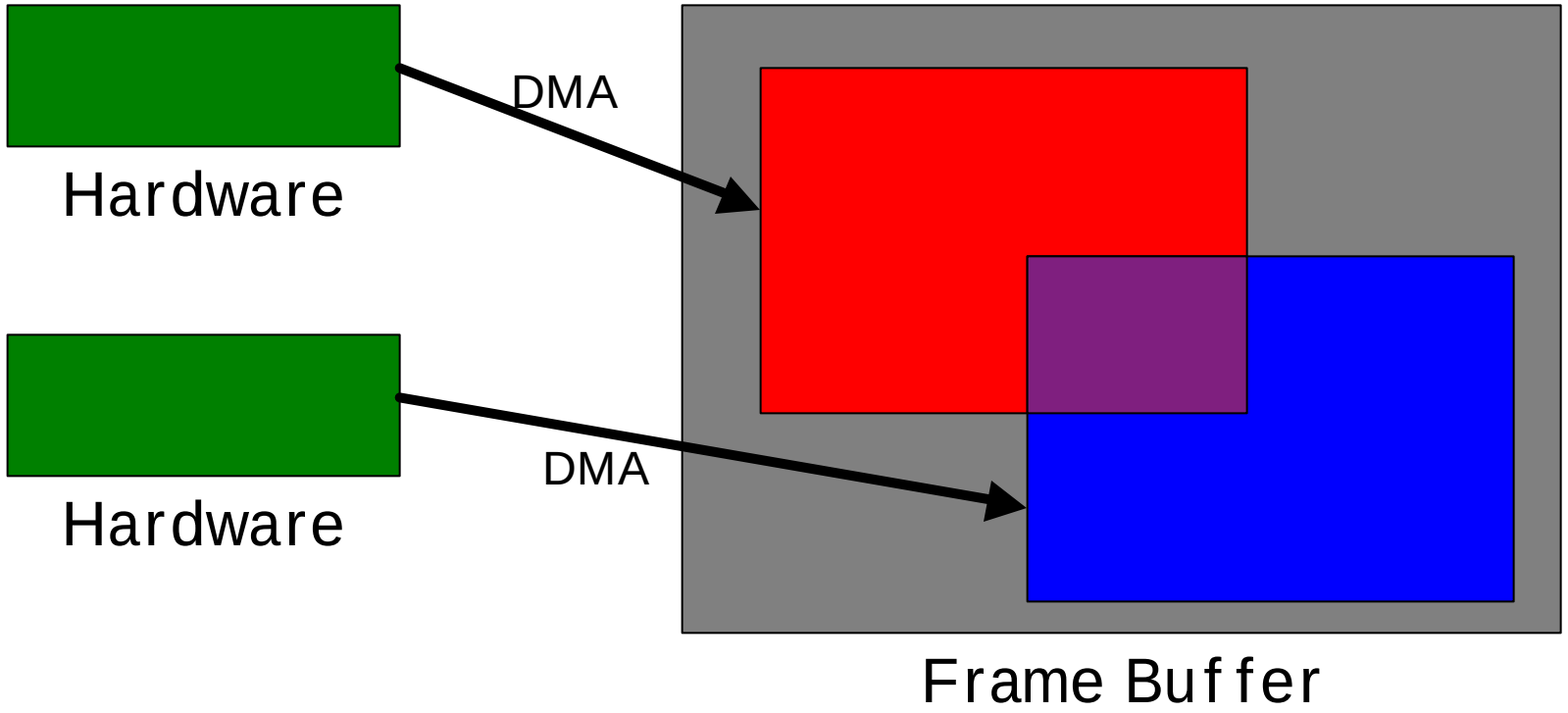
- Scenario #1: Present Situation



- Problem: Restricted allocation of projectors

RTPtv/AG Integration

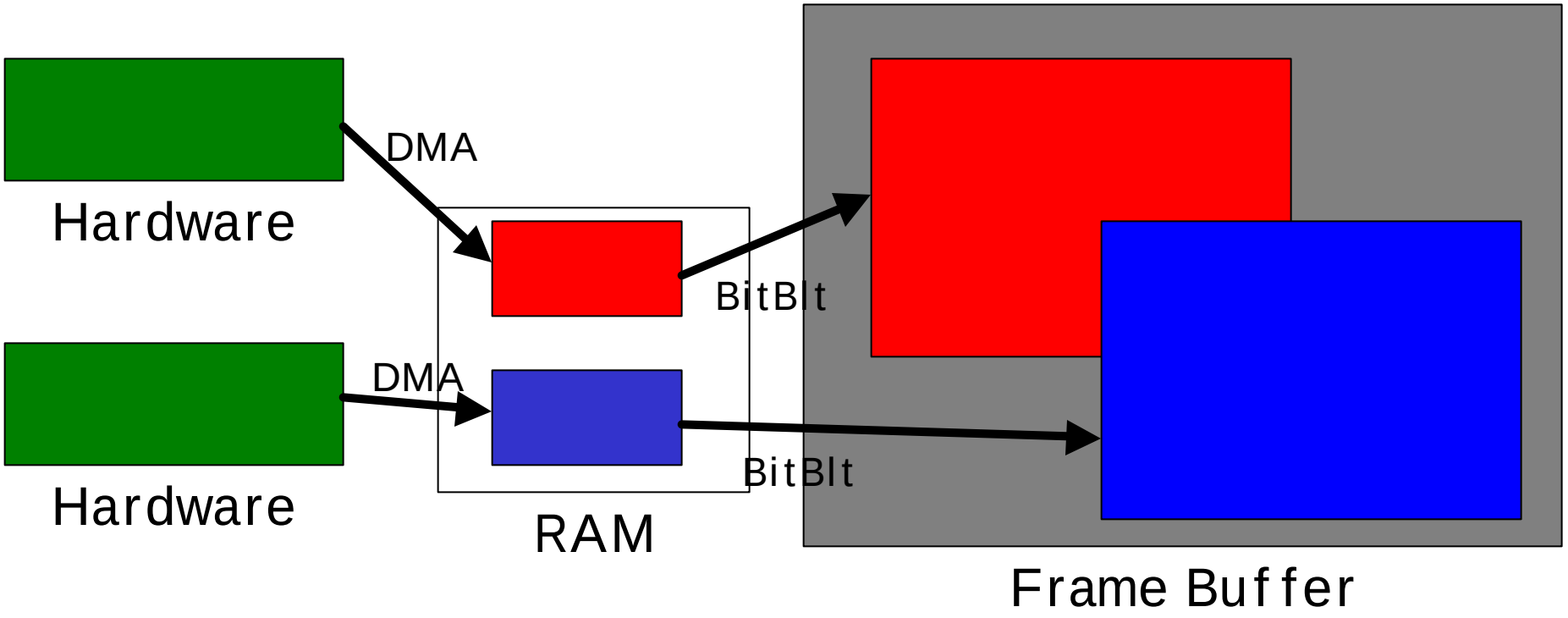
- Scenario #2: AG Support Hardware Decoders



- Problem: Window GUI System Support
  - Need new hardware / software support? (Marvel G400)

RTPtv/AG Integration

- Scenario #3: Introduce additional copies



RTPtv/AG Integration

- Hardware
  - Hardware needs to be smarter
    - Multimon support is doubtful
  - DMAs / PCI bus can cause issues
  - Dual bus, or faster bus, would help
- Software
  - “multicast tools” are not multi-threaded
  - CPU scheduler introduces jitter in rendering
  - MPEG
    - Introduces latency
    - Decoders rely on hardware too

RGB Video

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RGB Technical Overview

- PCs use RGB video (not equiv. to NTSC RGB)
- Video capture cards only support NTSC/PAL
- Solution: scan-convert RGB to NTSC or PAL
  - Problem: scan-conversion degrades quality
- Alt. solution: read out of PC's RGB frame buffer
  - Open Mash vic supports UNIX & MS Windows
  - Problem: requires software to run on local machine
    - PC owner may object to software installation
    - Software may not work on PC (e.g., OS X)

RGB Technical Overview

- Alt. solution: Multicast PowerPoint
  - Problem: Product specific; not supported by MS
- Alt. solution: download ppt, pdf, ps file
  - Problem: Viewer need to advance slides
- Alt. solution: find/make a RGB capture card

RGB Capture Card

- Datapath (Derby, UK)
  - VisionRGB Capture Card ($1k)
    - Can capture 2 screens simultaneously
    - Driver / SDK available for MS Windows
    - 640x480, 800x600, 1024x768 (66Mpixel/sec)
    - Image captured as 555, 565, or 888 pixels
    - up to 20 frames/second
    - Wire requirements:
      - RGB plus HSync and VSync
      - RGB with Sync on Green
  - VisionRGB-PRO card supports 1600x1200 (280Mp/sec) & “RGB with Composite Sync”

RGB Capture Software

- Open Mash allows RGB capture on MS Windows
- RGB capture handled the same as NTSC capture
  - Since images are large, JPEG codec is used
  - Future codec options: raw pixels, RLE, etc.
- Typically transmit 1 frame per second
- OM making improvements to JPEG software
  - DCT cache for improved encode performance
  - Restart markers / partial frames
- Some issues to be resolved
  - Software buggy, signal auto-detect, 5-pin RGB

Web Links

- RTPtv
  - Web page:
    - http://bmrc.berkeley.edu/~delco/rtptv/
  - Technical report:
    - http://bmrc.berkeley.edu/papers/2001/161/
- Open Mash:
  - http://www.openmash.org/
- Linux Media Labs (JPEG hardware) web site:
  - http://www.linuxmedialabs.com/
- Datapath (RGB hardware) web site:
  - http://www.datapath.co.uk

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